

Case Report Rapport de cas

Management of airway difficulties during induction of general anesthesia in an American miniature horse with dwarfism

Cindy L. Hatfield, Christopher B. Riley

Abstract — This report describes previously unreported upper airway abnormalities encountered in a 5-month-old American miniature horse colt presented for elective surgery. Caution should be exercised when administering general anesthesia or heavy sedation to individuals of this breed that present with multiple congenital abnormalities.

Résumé — Conduite à tenir en présence de difficultés respiratoires pendant l'induction de l'anesthésie générale chez un cheval miniature américain atteint de nanisme. Ce rapport décrit des anomalies jamais rapportées des voies respiratoires supérieures d'un cheval miniature américain âgé de 5 mois présenté pour une chirurgie élective. La prudence devrait être de mise lors de l'administration d'une anesthésie générale ou d'une forte sédation aux individus de cette race qui présentent des anomalies congénitales multiples.

(Traduit par Docteur André Blouin)

Can Vet J 2007;48:188–191

Based upon documented reports and discussion among breeders and owners of American miniature horses (AMH), the American Miniature Horse Association (AMHA) passed a resolution in 1989 prohibiting the registry of AMHs displaying 2 or more characteristics of dwarfism, as published by Ashby (1). Some of these characteristics include facial deformities (bulbous head, flat nasal bridge with constrained passages); limb deviations, including fetlock and pastern valgus or varus deformities; premature arthritic changes; dental problems (including severe underbite); and spinal deformities involving protruding spinal vertebrae or hunched backs. Dwarfism in the AMH is widely speculated to be heritable, with reports in the lay press that dwarfs may be born to normal parents (2). In the Shetland pony, defects associated with dwarfism have been identified as inherited via an autosomal recessive trait (3).

Case Description

A 5-month-old, 26 kg, AMH colt was referred to the Atlantic Veterinary College, Veterinary Teaching Hospital, for surgical treatment of bilateral carpal valgus. The owners requested treatment consisting of bilateral transphyseal bridging and hemicir-



Figure 1. Photograph of the 5-month-old American miniature horse colt with dwarfism. Note the domed forehead, long hair coat, and general dysmaturia. The severe forelimb valgus and brachygnathia that were present are not visible.

cumferential transphyseal periosteal elevation. On physical examination, the horse was considered to be developmentally small for its age, with thin body condition (BCS 2/6). The horse was bright, alert, and responsive. Heart rate was 60 beats per minute, respiratory rate 20 breaths per minute, rectal temperature 37°C, mucous membranes pink, and capillary refill time less than 2 s. Based upon radiographic examination, the horse had ~18 degree carpal valgus of the left forelimb, 10 degree carpal valgus of the right forelimb, and signs of osteoarthritis in the left middle carpal and carpometacarpal joints. The cranium was dome shaped, the abdomen round and pendulous, and the hair coat abnormally long (Figure 1). Marked brachygnathia was also evident. These features were consistent with brachycephalic dwarfism (1,2). Abnormal values determined by presurgical hematological and serum biochemical evaluation included

Veterinary Teaching Hospital (Hatfield); Department of Health Management (Riley); Atlantic Veterinary College, University of Prince Edward Island, 550 University Avenue, Charlottetown, Prince Edward Island C1A 4P3.

Dr. Hatfield's current address is Department of Small Animal Clinical Sciences, Virginia-Maryland College of Veterinary Medicine, Phase 2 Duck Pond Drive, Blacksburg, Virginia 24061, USA.

Address all correspondence to Dr. Hatfield; e-mail: drhat@vt.edu
Reprints will not be available from the authors.

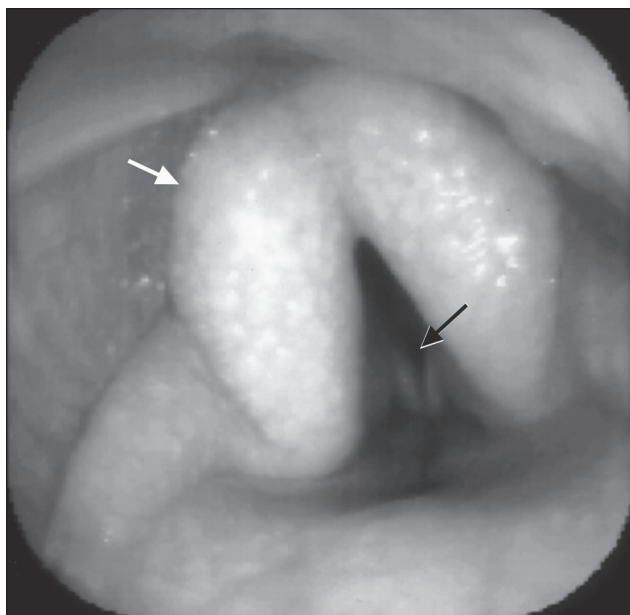


Figure 2. Endoscopic view of the airway of the American miniature horse shown in Figure 1. Note the markedly thickened arytenoid cartilages (white arrow), large epiglottis (foreground), and small rima glottidis (black arrow).

a packed cell volume of 0.277 L/L (normal range, 0.32 to 0.52 L/L), hemoglobin 105 g/L (normal range, 110 to 190 g/L), and increased alkaline phosphatase 372 U/L (normal range, 95 to 233 U/L). The latter abnormality was attributed to the young age of the horse. A fecal analysis revealed a heavy strongyle egg count; the anemia was attributed to this.

A 12-hour preoperative fast was followed by placement of an IV catheter in the right jugular vein. Preoperatively, gentamicin sulfate (Gentamicin 100 mg/mL; The Butler Company, Dublin, Ohio, USA), 6.6 mg/kg body weight (BW), sodium penicillin (Crystapen 40 000 IU/mL; Bioniche pharma, Belleville, Ontario), 20 000 IU/kg BW, and phenylbutazone (Univet 200 mg/mL, Pharmaceuticals, Milton, Ontario), 4.4 mg/kg BW, were administered, IV. The horse was sedated with xylazine HCl (Xylamax 100 mg/mL; Bimeda MTC Animal Health, Cambridge, Ontario), 0.3 mg/kg BW, IV, and butorphanol tartrate (Torbugesic 10 mg/mL; Fort Dodge Animal Health, Iowa, USA), 0.07 mg/kg BW, IV. Profound sedation was evident after 5 min. General anesthesia was induced with ketamine HCl (Vetalar 115.4 mg/mL; Veterpharm Canada, London, Ontario), 2 mg/kg BW, IV, and diazepam (Diazepam 5 mg/mL; SABEX, Boucherville, Quebec), 0.3 mg/kg BW, IV. Blind oral intubation in left lateral recumbency was attempted with a 12-mm ID cuffed endotracheal tube. Several attempts to intubate were unsuccessful. Several smaller tubes were utilized in an attempt to secure the airway either orally or nasally. Both nasal openings were so small that insertion of the primary author's 5th digit, in an attempt to intubate nasally, was impossible. The diameter of the nasal passage was estimated to be 6-mm. Two boluses of ketamine HCl (20 mg each) were administered, IV. Visual intubation, with the horse in sternal recumbency, using a large blade laryngoscope, polypropylene rigid stylet, and 8-mm ID endotracheal tube was attempted. Another 20 mg bolus of

ketamine HCl was administered, IV, and the mouth held open. Abduction of the mandible by using both manual retraction and a small 5-cm polypropylene mouth gag was limited. On visual examination of the oral cavity, the tongue appeared to be fleshy and larger than normal, relative to the size of the oral cavity. In addition, the soft palate appeared to be excessively large in proportion to the oral cavity, partially obstructing visualization of epiglottis and the arytenoid cartilages. After repeated intubation attempts, the horse became cyanotic, so intubation was delayed and 100% oxygen was administered via a facemask.

A video endoscope was passed, PO, with the horse in sternal recumbency, after preoxygenating for 10 min and administering an additional 20 mg of ketamine HCl, IV. The epiglottis was large, markedly thickened, and partially obscured by the soft palate. Both arytenoid cartilages were markedly thickened, but they abducted equally on inspiration and surrounded a very small glottis (Figure 2). A rigid stylet was advanced between the arytenoid cartilages as a guide and a 7.5-mm ID endotracheal tube (34 cm, length) was advanced over the stylet into the trachea. The endotracheal tube fit snugly and had to be carefully manipulated through the larynx. The area corresponding anatomically to the cricoid cartilage impeded the passage of the endotracheal tube. The rostral part of the larynx appeared to be funnel shaped, with the narrowest portion caudal to the vocal folds and within the cricoid ring. Caudal to the cricoid ring, the tracheal diameter was somewhat larger than that of the larynx. Once in place, the endotracheal tube cuff required 6 mL of air to form a secure seal with the trachea.

Surgery proceeded without incident, with the horse in dorsal recumbency, and anesthesia was maintained with isoflurane (Isoflurane USP; Abbott Laboratories, Saint Laurent, Quebec), 2.0% to 2.5% in 100% oxygen (1–2 L/min). Respiration was spontaneous and lactated Ringer's solution was administered, 10 mL/kg BW, IV. After 1.5 h, spontaneous nasal reflux began and the head was lowered slightly over the edge of the table to allow for drainage of secretions from the nasopharyngeal area. The exact cause of this is unknown and a rare event for anesthetized healthy equines. The endotracheal tube cuff was checked to ensure a seal with the tracheal wall was still present. Butorphanol tartrate, 0.1 mg/kg BW, IV, was administered 30 min prior to recovery. Total duration of general anesthesia was 195 min.

Secretions and fluid in nasal, pharyngeal, and esophageal areas were suctioned prior to recovery. The horse was placed in sternal recumbency with the head sloping downward, the nasal mucosa was sprayed with approximately 10 mg (0.4 mg/kg BW) of phenylephrine (phenylephrine HCl, Neo-Synephrine 10 mg/mL; Bayer Corporation, Morristown, New Jersey, USA) and maintained on 100% oxygen (2 L/min). Extubation was delayed until a strong swallow reflex was detected and the endotracheal tube was removed with the cuff partially inflated. Approximately 1 min post extubation, the horse's mucous membranes became cyanotic and marked inspiratory stridor was heard. The tongue was extended forward and oxygen administered via facemask at 2 L/min. After 30 min, the horse had recovered sufficiently to be returned to its stall. Two days later the horse was discharged without incident.

Discussion

This report documents some unexpected difficulties encountered with airway management in an American miniature horse (AMH) with characteristics of dwarfism. Dwarfism in AMHs has not been well described, with only 1 report of the condition in the scientific literature (3). However, its occurrence has been widely discussed in the lay literature (1,2). The authors have attempted to characterize the features of dwarfism in this breed, and discuss different manifestations of dwarfism in AMHs (1,2).

Dwarfism is defined as an animal of abnormally small size. The condition has been documented in horses, cattle, sheep, goats, cats, dogs, and humans. There are 2 recognized categories of dwarfism: 1) Achondroplastic (chondrodystrophic) dwarfism is characterized by individuals having a normal-sized torso, neck, and head, with abbreviated leg length (2). This condition is commonly seen in several dog breeds including dachshunds, basset hounds, Norwegian elkhounds, and Welsh corgies. These animals have normally proportioned bodies but abnormally short limbs that may have associated valgus deformities. 2) Brachycephalic dwarfism is characterized by a domed head, compressed muzzle, and reproductive difficulties, especially dystocia (2). Other manifestations include several upper respiratory tract abnormalities, stenotic nares, elongated soft palate, everted laryngeal sacculles, redundant soft palate, and in some instances, hypoplastic trachea (4). Dog breeds commonly affected include the pug, bulldog, shih tzu, Boston terrier, Pekingese, and Pomeranian.

The miniature horse in this report shares some features of dwarfism described in other species (4). The nasal opening in this colt was very small, possibly due to partial choanal stenosis. Partial choanal stenosis has been reported in the horse, but caution is indicated in reaching this diagnosis, due to the lack of ability to accurately compare the nares of this colt with other similarly aged AMHs (5). The colt was able to breathe comfortably via the small nasal passage when conscious. No attempt was made to access exercise intolerance in this individual due to the severe orthopedic lameness for which it was presented.

Normally, horses are intubated relatively easily, utilizing a blind technique (6). This horse presented several anesthetic related challenges, normally associated with brachycephalic canine patients. Dogs of a similar weight usually accommodate a 9–10 ID endotracheal tube, and normal AMHs of this size typically accommodate endotracheal tubes of 10–12 ID.

An apparently redundant soft palate was evident, in addition to a large fleshy tongue, complicating attempts at visual intubation. Since no hypoplastic lingual or palatal abnormalities were observed, the authors attributed the relative disproportion of these structures to a small pharyngeal vault associated with the craniofacial conformation of the horse. The larynx appeared to be narrow and presented the greatest obstacle to orotracheal intubation. The findings on endoscopic examination of a narrow funnel-shaped larynx led the authors to conclude that it was hypoplastic or stenotic. Laryngeal stenosis has been described in larger horse breeds and humans, but most commonly it has been associated with surgery or previous nasotracheal intubation

(7,8). In horses, it is rare, whereas, in man, up to 40% of cases are considered congenital in origin (8). In this AMH, there was no history or evidence of surgical trauma or intubation prior to presentation. This defect is associated with exercise intolerance or inspiratory noise in larger horses, but neither of these was observed in this case (7). Given the range of conformational abnormalities with which this colt was diagnosed, it is most likely that nasal, pharyngeal, and laryngeal abnormalities were due a congenital or developmental etiology. There has been 1 report of tracheal chondrodysplasia in an AMH (9). Other published reports of airway abnormalities in the AMH are lacking.

American miniature horses are frequently presented with congenital abnormalities. However few, if any, have been well characterized. The presence of severe bilateral carpal valgus, pronounced brachygnathism, and a domed cranium seen in this AMH has been associated with dwarfism in the breed, as have other orthopedic conditions (1,2,9–12). No figures are available on the prevalence and characterization of congenital defects in AMHs.

Recovery complications (dyspnea/cyanosis) can be attributed to airway obstruction from the redundant soft palate, dorsal displacement of the soft palate, or nasal edema. In this AMH, nasal edema was not observed and prophylactic treatment was administered per nasum to prevent this complication. When airway obstruction occurred post extubation, the animal had swallowed vigorously several times, and it seemed reasonable that airway clearance should have occurred, making dorsal displacement of the soft palate unlikely. Opening the mouth and pulling the tongue forward, as is performed in brachycephalic dogs experiencing airway difficulties, appeared to relieve the obstruction, and may assist in equine cases. Possibly, laryngeal edema occurring due to repeated intubation attempts contributed to recovery difficulties, but laryngeal edema would have persisted into the postoperative period and would not have resolved when the tongue was pulled forward. Clinically, the inspiratory stridor and airway obstruction was believed to be the result of pharyngeal collapse associated with the relative excess of the soft palate. Inspiratory stridor could also have been the result of reduced airflow due to the narrow external nares, but the AMH did not have stridor upon presentation. At extubation, the horse appeared to have symmetrical air flow through both nares when a hand was placed in front of the muzzle. Collapsing trachea was not observed during our rapid endoscopic examination of the upper airway and trachea.

This report outlines the necessity of planning several alternatives for airway management and having the supplies readily available should a difficult airway present. The initial approach is blind intubation, as per conventional technique for horses, but when this fails, visualization to secure the airway is recommended. Video endoscopy allows placement of the endotracheal tube and anatomic assessment of the upper airway.

From the author's experience, a number of recommendations can be made with respect to the sedation and handling of patients that show, or are suspected of, dwarfism. A thorough physical examination must be performed, with special attention being given to the upper airway. If the equipment

is available, an endoscopic examination of the upper airway is warranted, especially for any individuals exhibiting craniofacial abnormalities. Several drugs are available for sedating equids and for inducing general anesthesia. Administration of the alpha-2-agonists (xylazine, detomidine, or romifidine) results in profound sedation and muscle relaxation. When combined with opioids (butorphanol) for neuroleptanalgesic sedation, the degree of muscle relaxation can result in airway obstruction, so it is recommended that lower doses be used initially and the degree of sedation and airway patency be assessed before additional drugs are given. The advantage of administering solely alpha-2 agonists for sedation is the option to reverse their effects if the proposed procedure is not painful or if untoward complications occur. Other drug choices include acepromazine and the benzodiazepines (diazepam/midazolam) that produce minimal respiratory depression, but when they are combined with butorphanol for deeper sedation, there can be additive effects. The degree of muscle relaxation produced by the benzodiazepines may be undesirable in these individuals.

General anesthetic management of American miniature horses with dwarfism should parallel guidelines for handling the brachycephalic canine patient. Induction and recovery from anesthesia should be as rapid as possible. Airway management should consist of intubation with a cuffed endotracheal tube after 5 min of preoxygenation. The endotracheal tube should be removed when the patient is awake and swallowing. Induction of anesthesia can be accomplished with ketamine/diazepam, propofol, or thiopental, with the emphasis being on titrating to effect to allow intubation following premedication. Caution should be exercised with guaifenesin, as the degree and persistence of muscle relaxation may be undesirable. Oxygen should be available at recovery.

American miniature horses with dwarfism present a high risk for field anesthesia, owing to their small size, and the risk

may be minimized if general anesthesia is conducted in a clinic situation, since in the event of untoward complications, trained personnel are immediately available and the necessary equipment is at hand. In a field situation, the practitioner must always be aware that emergency airway management may be necessary in these individuals and have the necessary supplies on hand for a tracheostomy should the situation present itself.

CVJ

References

1. Ashby B. Dwarfism in miniature horses. *Min Horse World* 1989; Jun/Jul:37-9.
2. Jensen J. Dwarfism in miniature horses [monograph on the Internet]. Redmond, Washington:Mini Horse World c2002-2005. Available from <http://www.minihorseworld.com/Library/breeding/dwarfism/dwarfism.asp>
3. Bowling AT. *Horse Genetics*. Wallingford: CAB International, 1996: 100-101.
4. Hawkins EC. Disorders of the larynx. In: Nelson RW, Couto CG, eds. *Essentials of Small Animal Internal Medicine*. 1st ed. St. Louis: Mosby Year Book, 1992:176-179.
5. Richardson JD, Lane JG, Day MJ. Congenital choanal restriction in 3 horses. *Equine Vet J* 1994;26:162-165.
6. Shawley RV, Bednarski RM. Endotracheal intubation in the horse. In: Muir WM, Hubbell JAE, eds. *Equine Anesthesia: Monitoring and Emergency Therapy*. 1st ed. St. Louis: Mosby Year Book, 1991: 310-324.
7. Dixon PM, Railton DI, McGorum BC. Ventral glottic stenosis in 3 horses. *Equine Vet J* 1994;26:166-170.
8. Richardson MA, Osguthorpe JD. Surgical management of choanal atresia. *Laryngoscope* 1988;98:915-918.
9. Simmons TR, Peterson M, Parker J, Dietze A, Rebhun WC. Tracheal collapse due to chondrodysplasia in a miniature horse foal. *Equine Pract* 1988;10(10):39-40,42.
10. Englebert TA, Tate LP, Richardson DC, Honore EK, Little ED. Lateral patellar luxation in miniature horses. *Vet Surg* 1993;22:293-297.
11. Rosenstein DS, Schott HC, Stickel RL. Imaging diagnosis-occipitoatlantoaxial malformation in a miniature horse foal. *Vet Radiol Ultrasound* 2000;41:218-219.
12. Whitehair KJ, Adams SB, Toombs JP. Arthrodesis for congenital flexural deformity of the metacarpophalangeal and metatarsophalangeal joints. *Vet Surg* 1992;21:228-233.